

AN OVERLOOKED HYBRID JAPANESE KNOTWEED
(*POLYGONUM CUSPIDATUM* × *SACHALINENSE*;
POLYGONACEAE) IN NORTH AMERICA

PETER F. ZIKA¹ AND ARTHUR L. JACOBSON

Herbarium, Department of Botany, Box 355325,
University of Washington, Seattle, WA 98195-5325

¹e-mail: Zikap@aol.com

ABSTRACT. A new combination is provided for the hybrid between *Polygonum cuspidatum* and *P. sachalinense*. The hybrid, *Polygonum ×bohemicum* (J. Chrtek & A. Chrtková) P. F. Zika & A. L. Jacobson, *comb. nov.*, is widespread and invasive across North America. We illustrate the parents and hybrid, and supply a key to distinguish the three taxa.

Key Words: Polygonaceae, hybrid Japanese knotweed, *Polygonum ×bohemicum*, invasive plants

Polygonum cuspidatum Siebold & Zucc. and *P. sachalinense* F. Schmidt ex Maxim. (Polygonaceae) are common naturalized members of the flora of North America. They are native to northeastern Asia, and are noted for their large size and formation of extensive rhizomatous colonies. Their hybrid is little known, and is not even mentioned in the catalog of North American plants by Kartesz (1999), although hybrids in the group have been studied elsewhere (Bailey and Stace 1992; Bailey et al. 1996; Kim and Park 2000). However, all three taxa have a long history of economic importance—first as garden ornamentals, then as invasive adventives displacing native plants (Brock et al. 1995; Townsend 1997). In Europe *P. cuspidatum* was first cultivated in the 1840s, whereas *P. sachalinense* has been grown as an ornamental since 1864 (Bailey and Conolly 2000). Their hybrid was grown in English gardens from 1872 onward, although only recently was the parentage recognized (Bailey and Conolly 2000). Their value as ornamentals has perhaps now been surpassed by the cost of control for these three invasive and dominating taxa (Bailey et al. 1995; Sukopp and Starfinger 1995). *Polygonum cuspidatum* is widespread in North America, and classified as a noxious weed in North Carolina, California, Oregon, and Washington. *Polygonum sachalinense* is also established across the continent, and classified as a noxious weed in California and Washington (Kartesz 1999; Toney et al. 1998). In Great Britain, *P. cuspidatum* is considered the “nation’s most pernicious weed” (Townsend 1997).

[near spa of Běloves, not far from Náchod], 15 Aug 1982, J. Chrtěk & A. Chrtěková s.n. (Holotype: PR!). *Fallopia xbohemica* (J. Chrtěk & A. Chrtěková) J. P. Bailey, Watsonia 17(4): 443. 1989.

Hybrid Japanese knotweed, or Bohemian knotweed, *Polygonum xbohemicum*, has leaves intermediate in size between its parents (Figure 1). The leaves of *P. sachalinense* are thin, but the leaves of *P. xbohemicum* and *P. cuspidatum* are thicker and tougher. Mid-stem leaves of *P. cuspidatum* are less than 18 cm long; in *P. sachalinense* they are often more than 30 cm long. The hybrid has leaves of intermediate length, sometimes approaching the length of one or the other of the parents. The hybrid is variable in the shape of the leaf base on mid-stem leaves. Most are slightly cordate, though they can approach the deeply cordate shape of *P. sachalinense* in some extremes, and the essentially truncate leaf base of *P. cuspidatum* on other plants (Figure 1). The mid-stem leaves of *P. sachalinense* are generally evenly tapered to a blunt or short-acute tip, while the corresponding leaves of *P. cuspidatum* are abruptly cuspidate and long acuminate. The hybrid has mid-stem leaf tips intermediate, generally long acuminate but not cuspidate. Mid-stem leaves are rarely seen on herbarium specimens. Another useful character in the field is plant habit. *Polygonum sachalinense* grows to 5.3 m tall in Seattle and branches sparingly. *Polygonum cuspidatum* is usually 1.5–2 m tall, but we have seen plants 2.5 m in height. It branches profusely. The hybrid is intermediate, usually 2.5 m tall, ranging from 2–3 m tall in some clones. Both parents and the hybrid can be stunted in exposed sites on the outer coast of Washington.

The three taxa are most effectively distinguished by pubescence on the underside of the leaves, which is easiest to find early in the growing season, from June through flowering in mid-September (Figure 2; Bailey et al. 1996). Later in the growing season many of the distinctive hairs are shed. In our experience, veins on the basal half of the leaf underside are the best place to see the characteristic hairs, but many herbarium specimens are mounted inconveniently. Pubescence on the upper surface or margin of the leaves is not diagnostic. Although the hairs of *Polygonum sachalinense* and *P. xbohemicum* are small, with practice they can be located with a 15–20× hand lens, by bending a fresh leaf to backlight the midvein against the sky. The swollen scabers characteristic of *P. cuspidatum* are more difficult to see without high magnification (30–40×), and are usually quite scattered. The inflorescence of *P. cuspidatum* has well-developed simple hairs. The diagnostic multi-

In our area, western Washington, the hybrid is more common in cultivation than *Polygonum cuspidatum* or *P. sachalinense*. In our field investigations we observed the hybrid had commonly escaped from ornamental plantings, and aggressively colonized riverbanks, roadsides, garden dumps, and disturbed ground. It can appear anywhere earth-moving activity might introduce a rhizome. In lowland Washington the hybrid is more abundant than either parent as a wild plant. We turned to the herbarium to determine its distribution outside of the Pacific Northwest, and we found that many specimens in this aggregate are misnamed. The hybrid is widespread in North America, yet unrecognized as such. For example, we found six publications with illustrations labeled *P. cuspidatum* that were actually the hybrid *P. cuspidatum* × *sachalinense* (Hickman 1993; Hitchcock and Cronquist 1964; Mitchell and Dean 1978; Radford et al. 1968; Strausbaugh and Core 1978; Whison 1991).

The hybrid was first recognized, studied, and named in Europe under the segregate genera *Reynouria* Houtt. (Chrtěk and Chrtěková 1983) and then *Fallopia* Adans. (Stace 1989). We agree with Bailey and Stace (1992) that *Reynouria* must be combined with *Fallopia*; there are species transitional between the two concepts. However, in contrast to those authors who give it the rank of genus, we believe that *Fallopia* is best placed as a section of *Polygonum* L. Base chromosome numbers are similar throughout the genus *Polygonum* s.l., excepting *Fagopyrum* Mill., but including all elements of *Fallopia* (Bailey and Stace 1992). Minor floral differences form the basis of division for most segregate genera in *Polygonum* L. (Ronse De Craene and Akeroyd 1988). The floral differences make good sectional or subgenus groupings within *Polygonum* s.l., similar to subgeneric rankings in *Solanum* L., *Prunus* L., *Juncus* L., or *Carex* L. We consider *Fallopia* (including *Reynouria*) a taxonomic synonym of *Polygonum*, as have virtually all North American authors (e.g., Douglas et al. 1999; Gleason and Cronquist 1991; Hickman 1993; Mitchell and Dean 1978; Voss 1985; Wolf and McNeill 1986, 1987). There is no name for this hybrid Japanese knotweed in the genus *Polygonum*, which we provide here.

***Polygonum xbohemicum* (J. Chrtěk & A. Chrtěková) P. F. Zika &**

A. L. Jacobson (*P. cuspidatum* Siebold & Zucc. × *P. sachalinense* F. Schmidt ex Maxim.), *comb. nov.* *Reynouria xbohemica* J. Chrtěk & A. Chrtěková, Čas. Nár. Mus., Odd. Přír. 152(2): 120. 1983. TYPE: CZECH REPUBLIC. Province of Bohemia: District of Náchod, prope balneas Běloves, non procul ab oppido Náchod

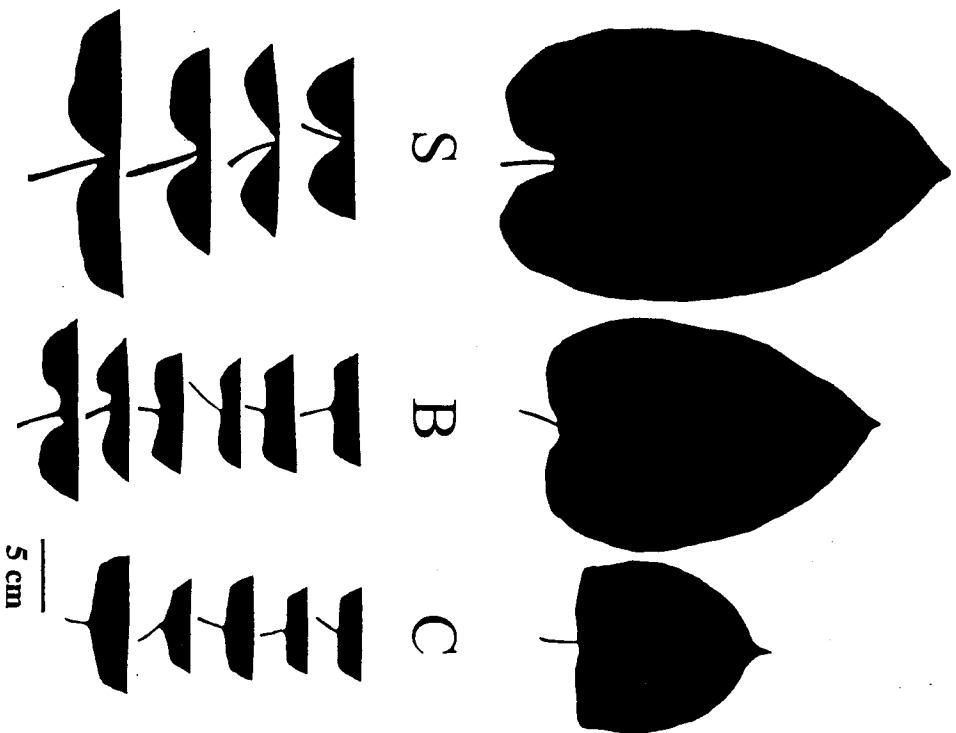
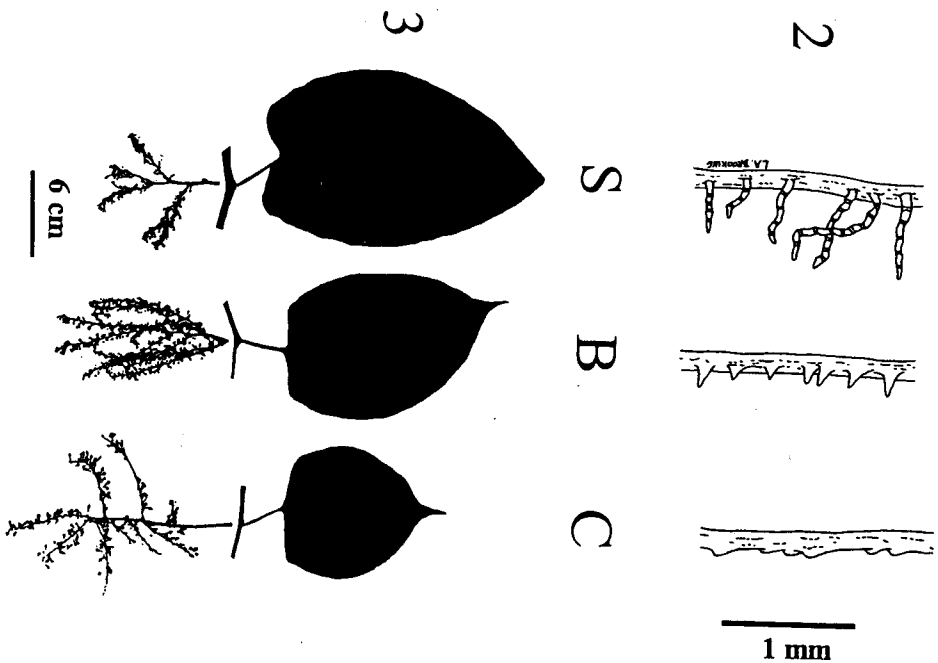


Figure 1. Leaf silhouettes for mid-stem leaves of *Polygonum*, showing variation in shape of leaf bases. S = *P. sachalinense*, note deeply cordate base, and short tip, acute to blunt (Zika 16464, WTU). B = *P. xbohemicum*, note base varies from deeply cordate to slightly cordate or essentially truncate; leaf apex gradually tapered, acute or acuminate (Zika 16624, WTU). C = *P. cuspidatum*, note truncate to slightly cuneate base; apex abruptly acuminate or cuspidate (Zika & Jacobson 16466, WTU).

cellular hairs of *P. sachalinense* are easily seen on the leaf underside. Usually some can also be found at the base of the upper leaf surface, or on the petiole, and they are common in the inflorescence. The hybrid has hairs intermediate in size and morphology between the parents.



Figures 2-3. *Polygonum* morphology. 2. Hairs on veins of lower leaf surface. S = *P. sachalinense*, narrow-based long multicellular hairs (Bernard B82-313, GH). B = *P. xbohemicum*, broad-based stout single-celled hairs (Halse 4299, GH). C = *P. cuspidatum*, blunt broad-based scabers or knobs (MacDonald 11408, MO). 3. Relative length of inflorescence and subtending mid-branch leaf. S = *P. sachalinense*, inflorescence < leaf (Zika 16464, WTU). B = *P. xbohemicum*, inflorescence variable, usually \leq leaf (Bean 15753, NEBC). C = *Polygonum cuspidatum*, inflorescence \geq subtending leaf (Zika & Jacobson 16466, WTU).

Characteristic hairs are scattered on the larger veins of the leaf underside, are simple, not multicellular, and are swollen at the base. Inflorescence hairs are mostly simple, like *P. cuspidatum*, but in some clones it is possible to find scattered multicellular hairs derived from *P. sachalinense*.

The inflorescence of *Polygonum cuspidatum* is typically longer than the subtending mid-branch leaf, whereas the inflorescence of *P. sachalinense* is much shorter than the subtending leaf at mid-branch. The hybrid inflorescences are usually intermediate in length relative to the length of the subtending mid-branch leaf (Figure 3).

The key below is written for use with fresh flowering material. In addition, unlike most herbarium collectors, avoid leaves from the tip of the flowering branches, as they are not characteristic in shape or size.

KEY TO THE *POLYGONUM* HYBRID AND ITS PARENTS

1. Veins of leaf underside with multicellular hairs (20×; Figure 2); mid-stem leaf bases deeply cordate; inflorescence much shorter than subtending mid-branch leaf *P. sachalinense*
1. Veins of leaf underside with simple hairs, or slightly and minutely scabrous (Figure 2); mid-stem leaf bases truncate to slightly cordate or slightly cuneate; inflorescence shorter or longer than subtending mid-branch leaf 2
2. Veins of leaf underside with scattered simple stout-based hairs; mid-branch leaf base usually slightly cordate; well-developed mid-stem leaves usually > 20 cm long .. *P. Xbohemicum*
2. Veins of leaf underside minutely scabrous with scattered swollen cells or knobs; mid-branch leaf base truncate (rarely slightly cuneate); largest mid-stem leaves < 18 cm long *P. cuspidatum*

The reproductive biology of *Polygonum Xbohemicum* and its parents is an interesting example of gynodioecious perennials reproducing primarily by vegetative means. In England, *P. cuspidatum* (var. *cuspidatum*) is represented by a male-sterile clone, and a similar situation seems to exist in western Washington. Although this clone often sets copious fruit, viable seeds are the result of pollen donation by *P. sachalinense*, *P. Xbohemicum*, or (in England) by *P. baldschuanicum* Regel (Bailey 1994). In western Washington, we have seen many dozens of examples of wild staminate clones of *P. Xbohemicum*, and only a few examples of fruiting *P. Xbohemicum*. What are the pollen

sources and vectors for the pistillate hybrid knotweed? How can backcrosses be detected? Further studies of breeding and reproduction by seed are merited. Apparently most reproduction of *P. cuspidatum*, *P. Xbohemicum*, and *P. sachalinense* is vegetative outside their native range (Bailey 1994, Bailey et al. 1995; Sukopp and Starfinger 1995). Our observations support this idea, suggesting the common *P. Xbohemicum* is not usually forming spontaneously from hybridization of the uncommon parents in lowland Washington; instead hybrids cultivated as garden ornamentals are spreading vegetatively. The hybrid and its parents regenerate from small fragments of stem or rhizome (Brock et al. 1995), and can form large exclusive stands. They are prevalent in riparian zones, where the clones are distributed by floodwaters. This suggests that planting the hybrid or its parents near river corridors should be discouraged, and that control of the three invasive taxa will be slow, expensive, and difficult.

REPRESENTATIVE SPECIMENS EXAMINED: CANADA. British Columbia: Captain's Cove, Ladner, 16 Oct 1971, *McLaren* 1 (UBC); Port Hardy, Vancouver Is., 3 m, 8 Sep 1986, *Reeve* s.n. (UBC); Queen Charlotte City, Graham Is., Queen Charlotte Is., 24 Aug 1997, *Loner & Grove* 97555 (V).

U.S.A. Connecticut: Hartford Co., South Windsor, floodplain of Scantic River, 4 Oct 1989, *Mehrhoff* 13114 (NEBC); Tolland Co., Willington, 9 Sep 1989, *Murray* 4 (NEBC). Idaho: Bonner Co., Pack River near Pend Oreille Lake, 730 m, 28 Sep 1986, *Johnson & Brunsfield* s.n. (ID); Idaho Co., Bimetric Cr. along Lochsa River, Clearwater National Forest, 550 m, 11 Sep 1987, *Johnson 87079 & Brunsfield* (ID); Lewis Co., Nez Perce, 24 Sep 1964, *Higgins* 8-64 (ID); Nez Perce Co., Garden Gulch Creek, rangeland 2 miles E of Lapwai, 415 m, 6 Jul 1993, *Lass & Carson* s.n. (ID). Illinois: Lae Co., Route 26 at Green River, 12 miles S of Dixon, 28 Sep 2000, *Ebinger* 29231 (EU); Peoria Co., Peoria Heights, waste ground, very obnoxious, 21 Aug 1950, *Chase* 11432 (WTO); Richland Co., 6 miles S of Noble, 16 Jun 1999, *Edgin* 3017 (EU); Wabash Co., 2 miles N of Mesa Lake, 16 Jun 1999, *Edgin* 3012 (EU). Iowa: Jones Co., Lovell Twp., 0.5 miles NE of Monticello, 15 feet tall, 28 Aug 1955, *Cooperider* 51 (RSA); Poweshiek Co., Grinnell, 16 Sep 1921, *Wittrock* s.n. (WTO). Louisiana: Claiborne Parish, W of Aycok, 26 May 1987, *Thomas* 99875 (ID, RSA, WCW); Ouachita Parish, aggressively spreading, Monroe, 13 Jul 1982, *Thomas* 81951 (RSA). Maine: Franklin Co., Stetson Twp., NW shore, Kennebag Lake, 27 Aug 2000, *Sonder & Angelo* s.n. (NEBC); Sagadahoc Co., Phillipsburg, 21 Jul 1948, *Bean* s.n. (NEBC); Somerset Co., Fairfield, Kennebec River island, 13 Aug 1968, *Bean & Harris* 33044 (NEBC). Maryland: Baltimore Co., marsh margin, 0.6 miles W of Loch Raven Reservoir, 23 Aug 1971, *Winkler & Lombard* 3773 (RSA); Calvert Co., Chesapeake Bay, Parkers Creek, 13 Sep 1965, *Meyer* 9289 (WS). Massachusetts: Dukes Co., Martha's Vineyard, Chilmark, 13 Aug 1962, *MacKenzie* 545 (NEBC); Essex Co., Haverhill, 14 Sep 1958, *Harris* 18605 (GH); Middlesex Co., Wakefield, 8 Sep 1915, *Bean* 15753 (NEBC); Plymouth Co., East Gate shopping mall, Brockton, 1 Sep 1981, *Perkins* s.n. (NEBC). Nebraska: Douglas Co., Omaha, Elmwood Park,

ravine, 5 Sep 1987, *Alfieri s.n.* (osc). New York: Bronx Co., Bronx, escaped on garbage dump, abundant, 18 Aug 1946, *Moldenke 18447* (osc). North Carolina: Madison Co., French Broad River, near Hot Springs, 23 Jul 1966, *Radford & Pence 45033* (osc, uc). Oregon: Lane Co., logging road, Middle Fork Willamette River, 8 Aug 1973, *Mason 9594* (ore, uc). Linn Co., N of Albany, Gibson Hill, 6 Aug 1957, *Sims s.n.* (gh, osc, ws). Multnomah Co., Columbia River Gorge, exit 40 on I-84, basalt cliff base, 31 m, 13 Sep 1991, *Halse 4299* (gh, mo, osc). Wallawa Co., trail, Innahwa River, 335 m, 8 May 1991, *Zika 11094* (osc). Pennsylvania: Cameron Co., 6 Sep 1940, *Wahl 806* (gh). Clearfield Co., Clearfield, recycling center, 17 Aug 1996, *Cook & Cook 557* (ws). Clifton Co., 2.5 miles NNW of Keating, 7 Oct 1951, *Wahl 12544* (uc). Lackawanna Co., Moosic, moist thicket, 31 Aug 1937, *Glowenke 1083* (gh). Tennessee: Polk Co., N of Copperhill, roadside denuded by copper smelter, 24 Apr 1965, *Illis 23281 et al.* (uc). Vermont: Caledonia Co., Waterford, *Gilman 92159* (gh). Virginia: Arlington Co., roadside near Arlington Forest, 18 Aug 1973, *Fosberg 55091* (gh, rsa). Washington: Chelan Co., E of Holden Village, 1005 m, 4 Jun 1993, *Naas 5660* (wtu). Clallam Co., W of Sequim, Dungeness River, 80 m, 27 Sep 2001, *Zika 16599* (wtu). Grays Harbor Co., Moclips, 5 m, 27 Aug 2002, *Zika 17685* (wtu). Island Co., Clinton, Whidbey Is., 60 m, 6 Sep 2001, *Zika 16498* (wtu). King Co., Green River, near Fort Dent Park, 5 m, 26 Aug 2000, *Zika 15404* (wtu). Kitsap Co., Bremerton, thickets, 30 m, 5 Sep 2001, *Zika 16488* (osc, uc, wtu). Mason Co., overgrown field, 6 m, 14 Sep 1977, *Buckingham 1517* (onp). Pacific Co., North Cove, Willapa Bay N shore, 3 m, 27 Aug 2002, *Zika 17705* (wtu). Pierce Co., Tacoma, vacant lot, 90 m, 19 Aug 1987, *Lewis s.n.* (wtu). San Juan Co., San Juan Is., Friday Harbor, 10 m, 4 Jun 1986, *Atkinson 249* (wtu). Skagit Co., I-5 near Starbird Road, 20 m, 20 Sep 2001, *Zika 16584* (wtu). Snohomish Co., Route 525, E of Lake Serene, 180 m, 6 Sep 2001, *Zika 16494* (mo, wtu). Stevens Co., Hunters Creek, Hunters, 475 m, 26 Sep 2002, *Zika 17958* (wtu). Thurston Co., Black River SE of Gate, 10 m, 18 Aug 2002, *Zika 17152* (wtu). Wahkiakum Co., Skamokawa, Brooks Slough, Columbia River, 10 m, 29 Aug 2002, *Zika 17727 & Weinmann* (wtu). Whatcom Co., 4 miles NE of Acme, 19 Sep 1962, *Heath s.n.* (wvb). Yakima Co., Yakima, wet ditch by railroad tracks, 320 m, 29 Sep 2001, *Zika 16635* (wtu). West Virginia: Kanawha Co., Ridenour Memorial Park, E end of lake, 185 m, 13 Aug 1999, *Tucker 11792* (eu). Wisconsin: Calumet Co., Niagara escarpment, N of lime kiln ruins, 24 Jul 1970, *Nee 3130* (uc).

ACKNOWLEDGMENTS. We thank John Bailey and Jennifer Forman for their discussions about the hybrid. Linda Brooking drew the pubescence figures. We are grateful to Jan Kirschner for translating the label of the holotype, and to Adolf Češka for translating the Czech paper describing *Reynouria Xbohemica*. For loans or access to collections, we thank the curators of the following institutions: A. AMES, EU, GH, ID, MO, NEBC, ORE, OSC, POM, PR, RSA, SPC, UBC, UC, UVIC, V, VT, WCW, WILLU, WS, WTU, WWB, as well as the herbarium of Olympic National Park, Port Angeles, abbreviated in the specimen citations as (onp).

LITERATURE CITED

- BAILEY, J. P. 1994. The reproductive biology and fertility of *Fallopia japonica* (Japanese Knotweed) and its hybrids in the British Isles, pp. 141–158. *In*: C. de Waal, L. E. Child, P. M. Wade, and J. H. Brock, eds., *Ecology and Management of Invasive Riverside Plants*. John Wiley and Sons, Chichester, U.K.
- _____, L. E. CHILD, AND A. P. CONOLLY. 1996. A survey of the distribution of *Fallopia Xbohemica* (Chrték & Chrtkova) J. Bailey (Polygonaceae) in the British Isles. *Watsonia* 21: 187–198.
- _____, AND M. WADE. 1995. Assessment of the genetic variation and spread of British populations of *Fallopia japonica* and its hybrid *Fallopia Xbohemica*, pp. 141–150. *In*: P. Pyšek, K. Prach, M. Rejmanek, and M. Wade, eds., *Plant Invasions: General Aspects and Special Problems*. SPB Academic Publishing, Amsterdam.
- _____, AND A. P. CONOLLY. 2000. Prize-winners to pariah—a history of Japanese knotweed s.l. (Polygonaceae) in the British Isles. *Watsonia* 23: 93–110.
- _____, AND C. A. STRACE. 1992. Chromosome number, morphology, pairing, and DNA values of species and hybrids in the genus *Fallopia* (Polygonaceae). *Pl. Syst. Evol.* 180: 29–52.
- BROCK, J. H., L. E. CHILD, L. C. DE WAAL, AND M. WADE. 1995. The invasive nature of *Fallopia japonica* is enhanced by vegetative regeneration from stem tissues, pp. 131–139. *In*: P. Pyšek, K. Prach, M. Rejmanek, and M. Wade, eds., *Plant Invasions: General Aspects and Special Problems*. SPB Academic Publishing, Amsterdam.
- CHRTÉK, J. AND A. CHRTKOVÁ. 1983. *Reynouria Xbohemica*, nový kříženeč z čeledi rdenovitéh. Časopis Národního Muzea V Praze Řada Přírodovědná 152: 120.
- DOUGLAS, G. W., D. MEIDINGER, AND J. POLAK, eds. 1999. *Illustrated Flora of British Columbia*, Vol. 3: Dicotyledons (Diapensiaceae through Onagraceae). British Columbia Ministry of Environment, Lands and Parks, Ministry of Forests, Victoria, BC, Canada.
- GLEASON, H. A. AND A. CRONQUIST. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*, 2nd ed. The New York Botanical Garden, Bronx, NY.
- HICKMAN, J. C., ed. 1993. *The Jepson Manual: Higher Plants of California*. Univ. of California Press, Berkeley, CA.
- HITCHCOCK, C. L. AND A. CRONQUIST. 1964. *Vascular Plants of the Pacific Northwest*, Part 2. Salicaceae to Saxifragaceae. Univ. Washington Press, Seattle, WA.
- KARTESZ, J. T. 1999. A Synonymized Checklist and Atlas with Biological Attributes for the Vascular Flora of the United States, Canada, and Greenland, 1st ed. *In*: J. T. Kartesz and C. A. Meacham, eds., *Synthesis of the North American Flora*. CD-ROM Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.
- KIM, J. Y. AND C.-W. PARK. 2000. Morphological and chromosomal variation in *Fallopia* section *Reynouria* (Polygonaceae) in Korea. *Brittonia* 52: 34–48.
- MITCHELL, R. S. AND J. K. DEAN. 1978. *Polygonaceae* (Buckwheat Family) of New York State. Bull. No. 431. New York State Museum, Albany, NY.
- RADFORD, A., H. E. AHLES, AND C. R. BELL. 1968. *Manual of the Vascular Flora of the Carolinas*. Univ. North Carolina Press, Chapel Hill, NC.

- RONSE DECRÆNE, L.-P. AND J. R. AKEROYD. 1988. Generic limits in *Polygonum* and related genera (Polygonaceae) on the basis of floral characters. Bot. J. Linn. Soc. 98: 321-371.
- STACE, C. A. 1989. New combinations in the British and Irish flora. Watsonia 17: 442-444.
- STRAUSBAUGH, P. D. AND E. L. CORE. 1978. Flora of West Virginia. Seneca Books. Grantsville, WV.
- SUKOPP, H. AND U. STARFINGER. 1995. *Reynoutria sachalinensis* in Europe and in the Far East: A comparison of the species ecology in its native and adventive distribution range, pp. 151-159. In: P. Pyšek, K. Prach, M. Rejmánek, and M. Wade, eds., Plant Invasions: General Aspects and Special Problems. SPB Academic Publishing, Amsterdam.
- TONEY, J. C., P. M. RICE, AND F. FORCELLA. 1998. Exotic plant records in the northwest United States 1950-1996: An ecological assessment. NorthW. Sci. 72: 198-209.
- TOWNSEND, A. 1997. Japanese knotweed: A reputation lost. Arnoldia (Jamaica Plain) 57: 13-19.
- VOSS, E. G. 1985. Michigan Flora, Part 2. Dicots (Saururaceae-Cornaceae). Cranbrook Inst. Sci. Bull. 59 and Univ. Michigan Herbarium, Ann Arbor, MI.
- WHITSON, T. D., ed. 1991. Weeds of the West. Western Society of Weed Science, in cooperation with Western U.S. Land Grant Univ. Coop. Exten. Serv., and Univ. Wyoming, Jackson, WY.
- WOLF, S. J. AND J. MCNEILL. 1986. Synopsis and achene morphology of *Polygonum* section *Polygonum* (Polygonaceae) in Canada. Rhodora 88: 457-479.
- AND ———. 1987. Cytotaxonomic studies on *Polygonum* section *Polygonum* in eastern Canada and the adjacent United States. Canad. J. Bot. 65: 647-652.